UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

PHYSICS **AUCKLAND PARK KINGSWAY CAMPUS**

PHYG01B

EXAMINATION
14 NOVEMBER 2014
8:30-11:00

PHYG01B

EXAMINER: **Prof H Winkler**

INTERNAL MODERATOR: Dr E Carleschi

TIME: 2½ HOURS **MARKS: 100**

Please read the following instructions carefully:

ANSWER ALL QUESTIONS: 1-6

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/Question 1

QUESTION 1 **[18]**

a) Compare on the microscopic level a hot body to a cooler body of the same material. (2)

b) Define the thermal expansion coefficient α. If you use a formula, define all terms in this expression. (3)

c) Briefly describe three processes by which heat can be transferred from one body to another. (6)

d) What term is used to describe water at a temperature below freezing point? (1)

e) The following two processes are applied to a balloon with 400 g of steam in it initially at 120°C.
i) The balloon is placed in contact with a warmer body, resulting in the temperature of the steam rising to 140°C while keeping the volume of the balloon constant. Determine the heat transferred to the steam (the heat capacity of steam is 2010 $J.kg^{-1}.K^{-1}$).
ii) After this, the volume of the balloon is increased by 0.250 m^3, while keeping the pressure of the steam constant at 100 kPa. Determine the work done on the steam. (6)

QUESTION 2 **[16]**

a) Use a rough sketch of a transverse wave to illustrate its wavelength. Furthermore explain in words how the speed of the wave is related to the wavelength. (3)

b) A large earthquake is reported near the boundary of two tectonic plates. Briefly
i) describe what caused this earthquake in terms of the physics of the process;
ii) explain how the epicentre (exact locality) of the earthquake may be determined using seismology. (7)

c) The speed of sound of air at 0° is 331 m/s. Calculate the speed of sound in air at a temperature where the air density is 0.90 times the air density at 0°. (3)

d) A body undergoes simple harmonic motion. The position of the body is determined by the following equation:

$$y = 4 \sin(5\pi t + \pi/2)$$ [where angles are given in radians]

Determine the period and frequency of oscillation. (3)

QUESTION 3 **[21]**

a) What process does the Curie point describe, and how can this process aid in the dating of geological formations? (6)

b) Compare the behaviour of electrons in metals to inside an insulator. (3)

c) Order the following in terms of increasing wavelength:
i) green light, ii) infrared light, iii) x-rays (3)

d) Why does a red shirt look red in the light and black in the dark? (2)

e) The potential difference across the ends of a 160 kΩ resistor is 12 V. Calculate the number of electrons passing through it in 1 minute. (4)

f) An object of height 8.0 mm is placed in front of a lens, forming an image behind the lens. The magnification of the setup is –0.25. Describe the image. (3)

QUESTION 4 **[18]**

a) Which two fundamental particles form the nucleus of an atom? (2)

b) How are emission lines generated in the spectrum of a gas? (3)

c) Distinguish between a planet, a moon and a meteorite. (4)

d) A cube with sides of 0.10 m radiates at a peak wavelength of 4.00×10^{-6} m.
i) Calculate the temperature of the cube.
ii) Determine the power radiated by the cube. (5)

e) A radioactive sample initially consists of 2.5×10^{16} particles of type A. The radioactive particles of type A decay to type B. 96 hours later the sample contains 8.0×10^{15} particles of type B (with the remainder still type A). What is the half-life of substance A? (4)

QUESTION 5 **[16]**

a) What is ozone and where is the ozone layer? (2)

b) Explain why an overabundance of greenhouse gases in the atmosphere can lead to global warming. (5)

c) Briefly explain the formation of a rainbow. (4)

d) A spherical particle of radius 1.50 mm and density 600 kg/m^3 is suspended in air with a wind speed of 16 m/s relative to the particle. Given that the viscosity of air is $\eta = 2.00\times10^{-5}$ Pa.s, determine the horizontal acceleration of the particle. (5)

QUESTION 6 **[11]**

a) How do medium temperature, particle size and viscosity impact on diffusion? (4)

b) A hosepipe has a radius of 5.0 mm, and the water flows through it with a speed of 2.4 cm/s. The water exits the hosepipe through a circular nozzle with a radius of 1.0 mm. With what speed does the water flow through the nozzle? (3)

c) Calculate the acceleration of a rock with a mass of 250 g and a volume of 1.20×10^{-4} m^3 in water (with density 1000 kg/m^3). (4)

END

Given equations:

$\lambda_{max} = (2.898\times10^{-3}\ \text{m.K})/T$ $\quad$ $\Delta E(2\text{H} + 2\text{n} \rightarrow 1\text{He}) = 4.272\times10^{-12}\ \text{J}$

$E_n = -(2.177\times10^{-18}\ \text{J})/n^2$ $\quad$ $N = N_0 \times \exp(-0.693 \times t/T_{1/2})$

$F_{\text{shear force}} = \eta A \Delta v/\Delta y$ $\quad$ $F_{\text{drag/sphere}} = 6\pi R v \eta$

Constants:

$c = 3\times10^8\ \text{m/s}$ $\quad$ $g = 9.8\ \text{m/s}^2$ $\quad$ $G = 6.67\times10^{-11}\ \text{N.m}^2/\text{kg}^2$ $\quad$ $h = 6.626\times10^{-34}\ \text{J.s}$

$k = 9\times10^9\ \text{N.m}^2/\text{C}^2$ $\quad$ $q_e = -1.6\times10^{-19}\ \text{C}$ $\quad$ $\sigma = 5.67\times10^{-8}\ \text{W.m}^{-2}.\text{K}^{-4}$